Chapter 4 Horizontal Alignment

There are a number of methods that can be used to create horizontal alignments in MX. In this section, we'll discuss two of them: The Horizontal Element Method, and Quick Horizontal Alignment. The advantages and disadvantages of both are described below:

The *Horizontal Element Method* is the most commonly used horizontal alignment tool, and allows the designer to place individual tangents and curves of an alignment, and link these elements together to form an alignment. The **advantages** of this method are:

- Fine control of element placement using a variety of means to define them.
- No need to calculate PI coordinates to define tangents
- Allows for the creation of reverse and compound curves
- MX calculates all control point information for the alignment by analyzing the relationship between elements.
- Alignment definitions can begin or end on a curve element.
- Alignment Stationing can be assigned relative to any point along the alignment, making it easier to tie proposed alignment to existing alignments.

The *Quick Horizontal Alignment Method* is a PI method that allows you to quickly and interactively place PI's on the drawing by simply clicking on points on the screen. The tangents of your alignment are automatically defined by the placement of the PI's. A default curve is automatically placed between each pair of adjacent tangents, that must be edited to suit your design. The **advantages** of this method are:

- Quick and easy interactive placement of PI's.
- Dynamic editing of PI locations using "drag and drop" method.

The **disadvantages** of Quick Horizontal Alignment are:

- Alignments must consist of alternating tangents and curves
- Doesn't allow the creation of reverse or compound curves.
- Can only assign a station value at first point of alignment.

Because of the way it works, compound curves, reverse curves, or other special alignments can't be created with Quick Horizontal Alignment. It is quite well suited for simple alignments or preliminary design work, however.

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The creation of these Horizontal Alignments is perhaps the most important step in the MX project development process, as all other design is based upon them. ***Changes required in the Horizontal alignment discovered later in the design process will require you to re-create all of your design strings to reflect the new alignment.*** JOURNAL files, which we will create in later steps, will help to save work should changes in your horizontal alignment become necessary, but many time-consuming activities such as the editing of strings will have to be performed again.

The Horizontal Element Method in Theory:

The traditional method of determining horizontal alignments for highway projects would be accomplished by laying out a series of straight lines, or tangents, and arcs, or curves, with manual drafting tools on paper plots. MX is simply a computerized tool to

accomplish the same work. The engineering and analysis of horizontal alignments remains the same.

NOTE: Those who are used to the manual drafting/design methods might find it easier to produce a paper roll plan from the drawings created in the previous step to sketch their preliminary work on. Once the designer has a good idea of what elements they would like in their design, it can then be reproduced using the MX tool on a plan display.

To begin a horizontal alignment in MX, obtain the latest "as-built" plans of projects for your project area to determine control points that can be used to tie in your MX alignment to the original Stationing of the roadway. These plans will also be valuable in determining existing curve data, tangent bearings, point coordinates, and vertical alignment information, which will be used in the next step of the MX design process. In the absence of as-built plans or an old surveyed centerline, the designer is free to determine his/her own stationing within the project limits. Some types of control points to search for in both the "as-built" plans, and the MX GROUND model include:

- Right Of Way Monuments
- Culvert locations
- Other points of known stationing such as railroad spikes picked up by the survey crew marking PCs and PTs of curves from earlier projects.

Once you've located this point of known stationing, make a note of it. It will be used later to create the Master Alignment String.

NOTE: Adjacent projects should be researched and coordinate information should be assembled from the team contact person, controlling the Right of Way information, for use when designing a new alignment. It's important to tie the beginning and end of your proposed alignment to a previously constructed project using known and recorded coordinated points if at all possible, because MDOT's right of way lines, easements, property condemnations, and other information about abutting properties are described based on these existing centerlines.

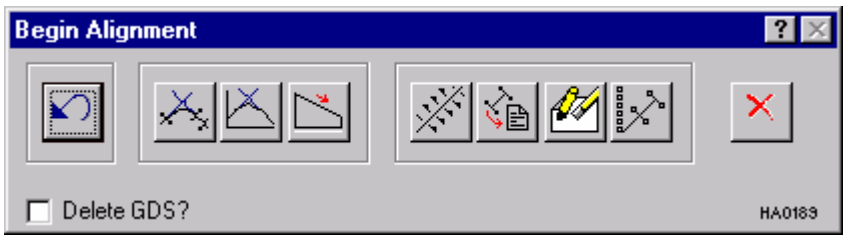
Creating the Horizontal ALIGNMENT in MX

Step 1. Select ***Design => Alignmen***t from the Menu Bar.

Step 2. Type the name of the model to hold your design (i.e. DESIGN, DESIGN2, etc.), then click the ***Next*** Button to continue. If the model you typed in doesn't yet exist, you'll be given an opportunity to create an empty model at this time.

NOTE: If you create a new model with the name beginning with "DESIGN", then the correct style and feature sets will automatically be assigned to this model. If you choose to deviate from the model naming standard, you'll need to manually set the model defaults to the correct string naming convention. It's highly recommended that you follow the standard procedures.

Step 3. The Begin Alignment panel will appear:



This is the main panel used to create and manage alignments. If you move your mouse over a tool on this panel, you should see a tooltip appear describing what this tool does. Here is a description of the tools commonly-used on this panel:

 ***Horizontal Alignment*** - This is the tool we'll be using in this step to create an alignment with the Horizontal Element Method.

 ***Vertical Alignment*** - This tool invokes the vertical element method which is described in Chapter 5B of this manual.

 ***Create Master String*** - Once a horizontal alignment has been defined, a master string is created using this tool.

 ***Create Data Output*** - Horizontal And Vertical Alignments created using the tools on this panel should be saved by creating Data Output Files which can be used later to regenerate your alignment should your model file become corrupt. It also can be sent to another MX user who is collaborating with you on a project.

 ***Alignment Management*** - Allows you to delete alignments, make parallel alignments, merge alignments, etc.

 ***Finish*** - Exit this panel

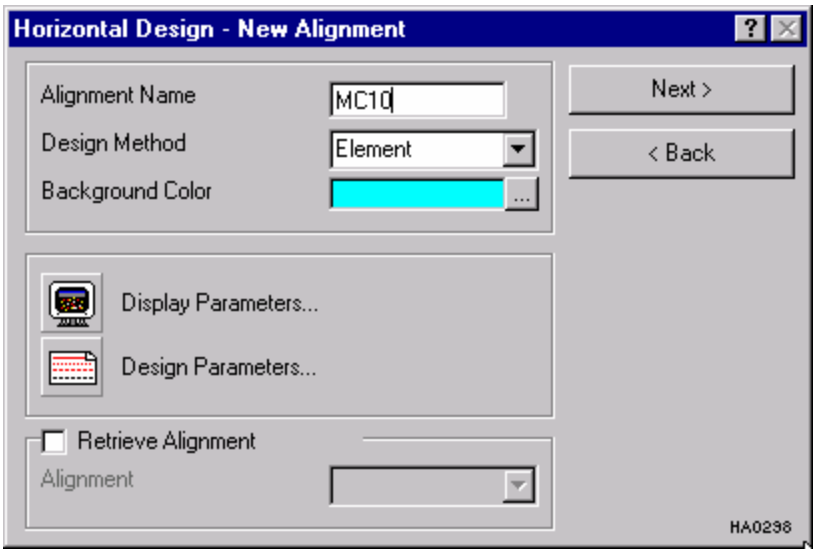
Step 4 - Click the ***Horizontal Alignment Tool.*** 

If this is the first alignment created for this model, you'll proceed directly to the Horizontal Design - New Alignment panel. If it's not the first alignment, you'll be prompted as to whether you wish to continue an existing alignment or to create a new one.

MX Master Strings all have labels beginning with the letter "M". Only Master strings may begin with this letter.

One type of MX Master String is the Roadway Centerline, and all Roadway Centerlines have the feature code "MC". These are often referred to as ***Master Alignments***.

In the example panel illustrated to the right, the Master Alignment will be labeled "MC10".



Each Master Alignment must have a unique 3rd character in it's string label. In the example above, the number "1" is used to denote the alignment number. I would suggest the following alignment naming convention:

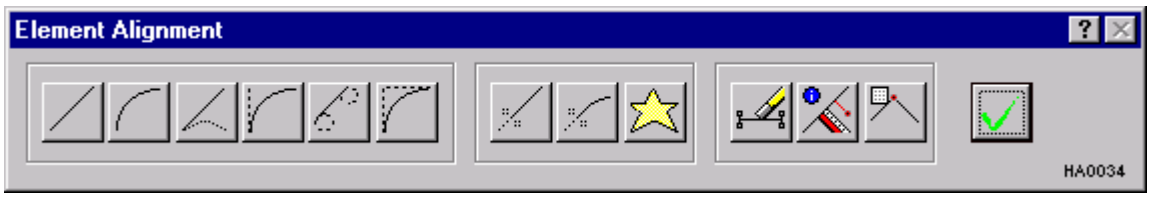
*Mainline roadway alignment alternatives - **1-9,0***
*Side Road alignment alternatives - **A-Z***

This convention provides a quick way to identify whether an alignment is a side road or mainline alignment. To further identify which side roads go with which mainlines, use the 3rd character of the mainline M-String label as the 4th character of the side road M-String label.

In other words, the side road alignments intersecting alignment MC10 could be labeled MCA1, MCB1, MCC1, etc. Side road alignments intersecting an alignment called MC20 would be labeled MCA2, MCB2, MCC2, etc.

NOTE: The best solution for evaluating multiple design alternatives is to create separate models for each alternative. That way you can use the same string label for your alignments. If you don't, you'll need to create complex string masking tables when it comes time to create cross sections or perform analysis tasks such as slope analysis. Mask tables can be used to specify which strings to cut and which to ignore.

Step 5 - Create The Alignment. Type the proposed alignment M-String Label, then click ***Next*** to continue. The element Alignment Toolbar will appear:



The group of 6 tools on the left of this toolbar are used to specify fixed, floating, and free elements in an alignment. From left to right these are:

 ***Fixed Straight*** - Create Straight as an independent element

 ***Fixed Arc*** - Create an arc as an independent element

 ***Float Straight*** - Create a straight linked to one adjacent element (arc only)

 ***Float Arc*** - Create an arc linked to one adjacent element (straight and/or arc)

 ***Free Straight*** - Create a straight linked to two adjacent elements (arcs only)

 ***Free Arc*** - Create an arc linked to two adjacent elements (straights and/or arcs)

The middle group of three tools are:

 ***Add Straight*** - Appends straight to an arc element.

 ***Add Arc*** - Appends an arc to a straight element.

 ***Special Geometry*** - Allows you to do special things like create a three-center curve, or more commonly to *create a single element alignment*.

The last group of tools are:

 ***Edit Alignment*** - A variety of tools to edit elements, links, and alignments.

 ***Clearance To Alignment*** - This allows you to click on points on the display to find the normal distance to your proposed alignment, or "clearance".

And finally:

 End this Alignment - This saves the current horizontal alignment information in the Geometry Data Store for this model.

Each of these tools will be described later in this chapter.

Element Fixity

Fixed Elements: A Fixed element is fully and independently defined by at least 3 items of geometric information or "constraints", one for each spatial dimension. For Example: A curve defined as passing through three distinct points is uniquely defined and is considered a fixed element. It can stand by itself and has not dependency with an adjacent element.

Floating Elements: Floating Elements are defined by 2 of its own geometric constraints. This allows one degree of freedom. This element becomes fully defined by relating it to an adjacent element in the alignment. For Example: A floating straight defined as passing through a point would be rotated until it is tangential to an adjacent curve.

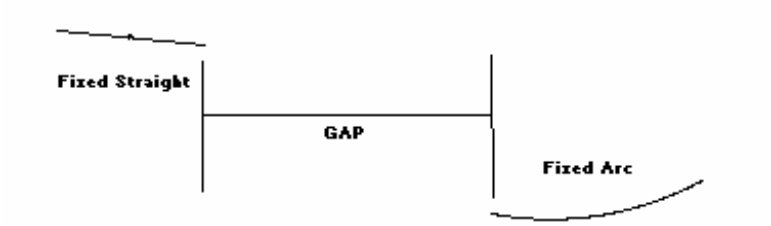
Free Elements: If only one item of geometric information is available, then there are 2 degrees of freedom, and the element is known as a "free element." The location of the element is resolved by considering the geometric elements on either side. For Example: Specifying the radius of an arc will move the center coordinates until the circle is tangential to two adjacent elements on either side.

Planning Your Horizontal ALIGNMENT Strategy

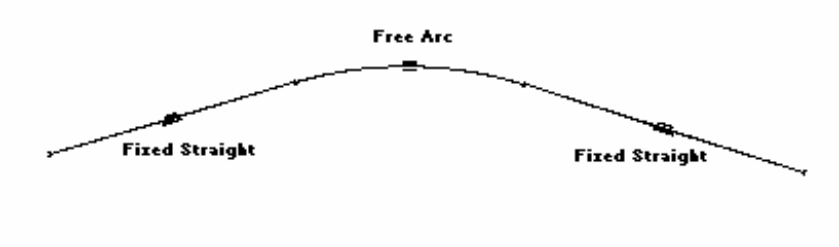
A key concept to remember, when defining elements of an alignment, is that at the end of the process, ***all elements must be "linked" together to form an alignment***. You cannot simply create a series of fixed elements along a roadway because they don't require a relationship or link to an adjacent element. By planning ahead, you will easily be able to determine which type of element to use for a given situation. ***A general procedure for use in creating an alignment with the element method is***:

1 - Place the Alignment's Fixed Elements

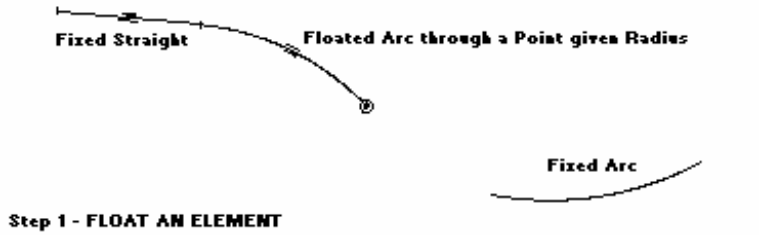
2 - Evaluate the "gap" between fixed elements to determine how many elements are required to connect them.



3 - If a single element will fill the gap, then that element should be defined as a "free" element, because it will be linked to the two fixed elements on either side of it. In the example below, two fixed straights are created, then a single free arc is created between the fixed straights, linking the three elements together.

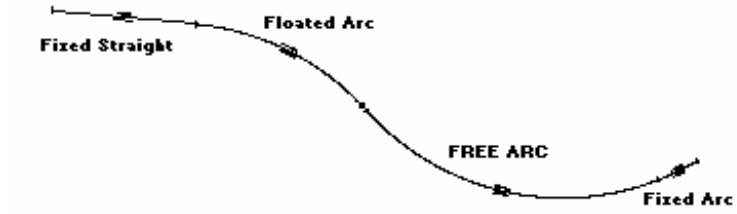


4 - If 2 elements are required to fill the gap (such as a reverse curve), then you should float an element from one of the fixed elements, then use a free element to connect the new floated element to the second fixed element.



Step 1 - FLOAT AN ELEMENT

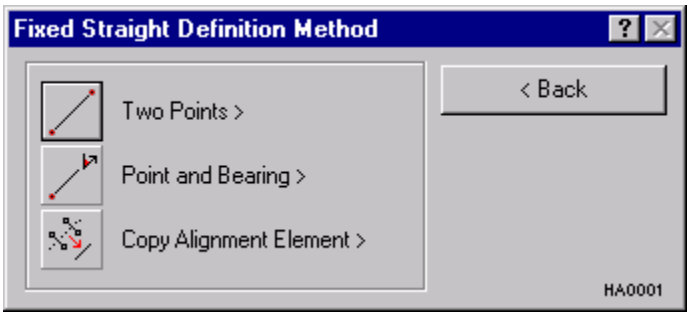
In this example, an arc is floated from the fixed straight element through a point and specified radius. This leaves a gap that can be filled by a single Free Arc.

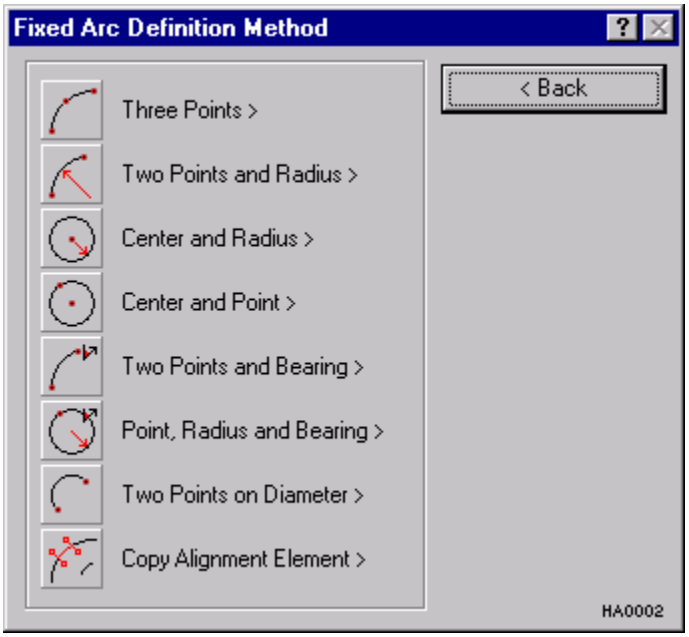


Step 2 - ADD FREE ELEMENT

5 - If more than 2 elements are required to fill the gap, then a wide variety of options are available to you. You can fix an element in the gap and float two more elements to connect all, or you can float a series of elements to fill all of the gap but the final element, then add a final free element.

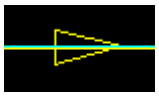
Fixed Elements A variety of methods are available to specify fixed straights and arcs.



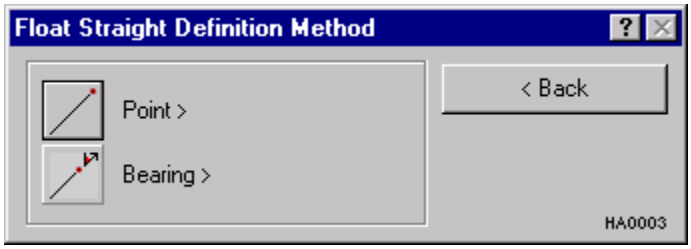


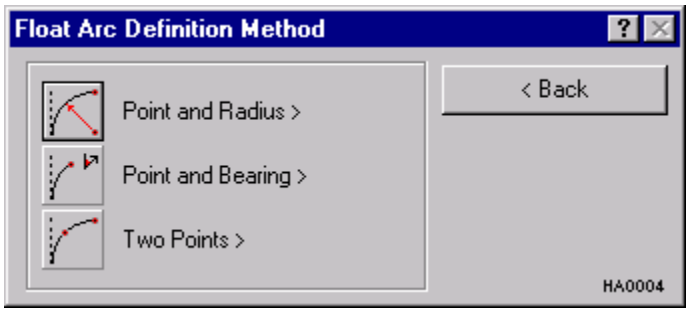
Since fixed elements are "stand-alone" elements that can be created independently, there will not be much detail provided in this manual as to how they are used. Their use is pretty much self-explanatory, so *I recommend you spend some time trying each of the tools out to see what information is required for each Method.*

It's important to keep in mind that elements have a "direction" to them. They should be defined in such a manner as to go in the direction of increasing stationing of your proposed alignment. If necessary, individual elements can be reversed later, but it's always easiest to orient them correctly when they are created. The direction of an element can be determined by the arrowhead symbol on them in the display area.



Floating elements - These are dependant on one adjacent alignment. This is called a "degree of freedom".





Compare the float straight definition panel illustrated to the left with the fixed straight definition panel at the top of this page. They are very similar. Instead of defining a straight by two points (as in the fixed method), a floated straight can be defined by only one point. The other "point" required to completely define this element is replaced by the relationship or link to an adjacent element.

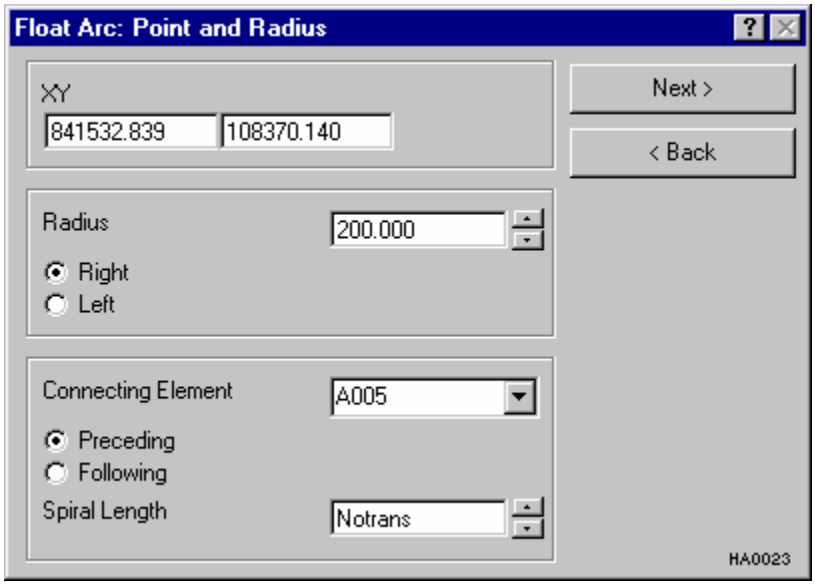
The float arc definition panel is also shown.

When specifying a floated element, a relationship must be established with an adjacent element. This element can come before or after the floated element relative to the direction of the finished alignment. It's a relatively simple procedure to establish this relationship.

For example: Assume that we have fixed a straight element, and want to ***float an arc from this element to a point given a radius***. 

The following panel would appear to define this element:

In the top portion of this panel, we can use any Point Selection Method we want to define the Point through which this element will pass.



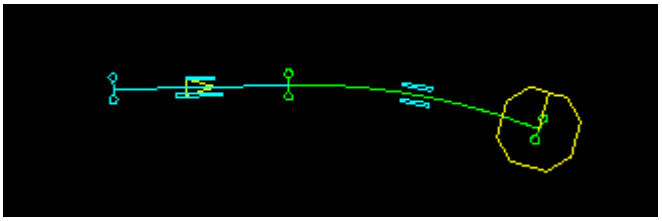
We then need to specify the radius of the arc, and whether it's a left-hand arc or right-hand arc.

The final portion of this panel is where we establish the link between this new element and the straight that comes before it. Select whether the connecting element is Preceding or Following the new floated arc, and then click on the connecting element in the display area to fill in the Connecting Element box.

NOTE: as elements are created for an alignment, they are automatically assigned a sequential element ID. In the example above, element A005 was the 5th element placed though it may be located anywhere within the alignment. This floated arc element we are placing in this example could very well be named A025 if it is the 25th element created. It's not necessary for element A006 to follow and be connected to element A005. In fact it rarely will unless you create an alignment comprised entirely of floated elements following an initial fixed element.

After clicking Next on the Float Arc panel, MX will perform calculations to determine the exact coordinates where this arc is tangent to the fixed straight. (i.e. the PC of the curve). It will then provide a preview of this point in the display:

The common tangent point calculated is shown as a "dumbbell" symbol.



If a mathematical solution is found to join these elements, you are given the opportunity to accept this element, or respecify the element. Once accepted into the alignment, these two elements are known as "LINKS" instead of "ELEMENTS". This is important to keep in mind if it becomes necessary to edit them later.

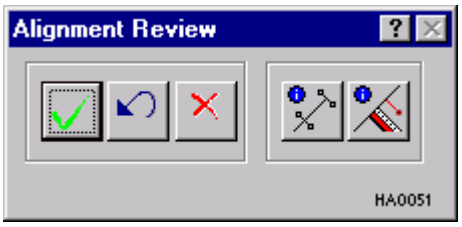
The Alignment Review Panel is displayed to allow you to decide whether or not to accept the new element:

The three buttons on the left of this panel are:

Accept |Modify|Abandon

The rightmost group of two buttons are:

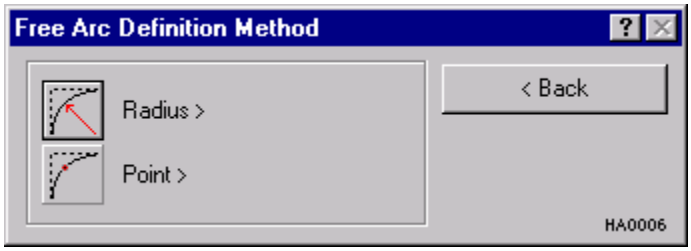
Alignment Summary | Clearance Checking



If a solution wasn't found, then you'll see a different panel asking indicating that an error occurred. At this point, you only have to option to modify the element definition, or to abandon this element altogether.

Free Elements - These are dependant on two adjacent elements. In other words, they have two "degrees of freedom".

When fitting a Free Straight element between two arcs, you are simply prompted for the preceding arc element and following arc element.

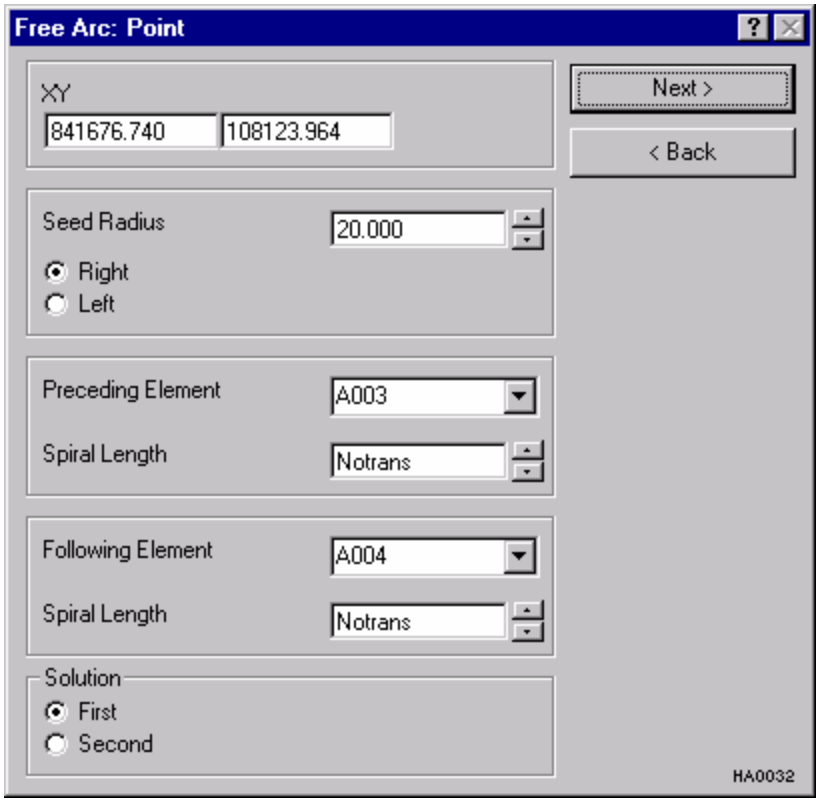


When creating a free arc element, you have two choices.

Here is the panel you would see if you select the "Point" option:

Note that even though we are specifying this free arc to fit through a specific point, we are asked to provide a "seed radius", and hand of arc.

*A **Seed Radius** simply gives MX a starting point to begin its iterative calculation of a "best-fit" curve between the two adjacent elements.*

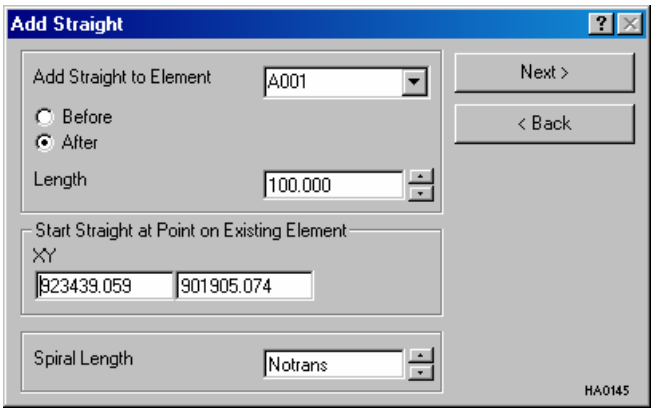


Unlike the floated element which only required you to select one adjacent element, a free element requires you to identify elements on either side of the free element to be able to define it.

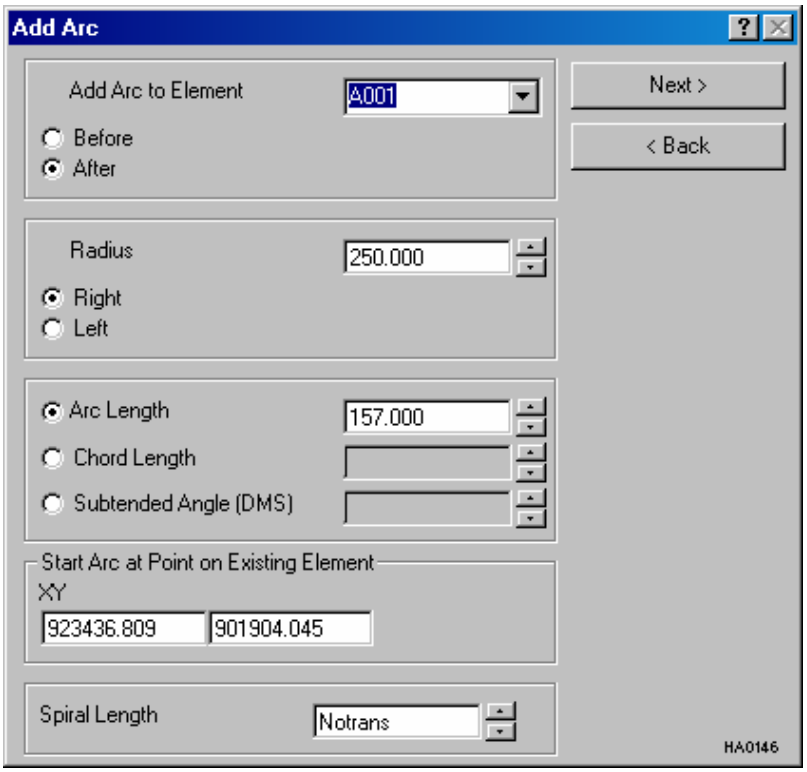
As with the floated element, if MX can calculate a solution to fit this element into the alignment, you will be prompted to accept, modify, or abandon this alignment element with the Alignment Review Panel.

Add Straight / Add Arc

With the fixed, free, and floating elements described above, MX calculates the points of tangency between elements and modifies these elements to fit. In some cases, you may find it necessary to specify tangent points in an alignment you are creating based on known coordinate geometry from previously-built projects. The Add Straight and Add Arc tools will enable you to reconstruct an alignment from known geometric information.
Add Straight appends a straight element of a given length from a point on an existing arc.
Add Arc appends an arc element from a specified point on an existing element.



This is the panel provided with the Add Straight tool. In the sample data shown, a 100ft long straight is being appended to an arc named A001 beginning at the point coordinates shown.

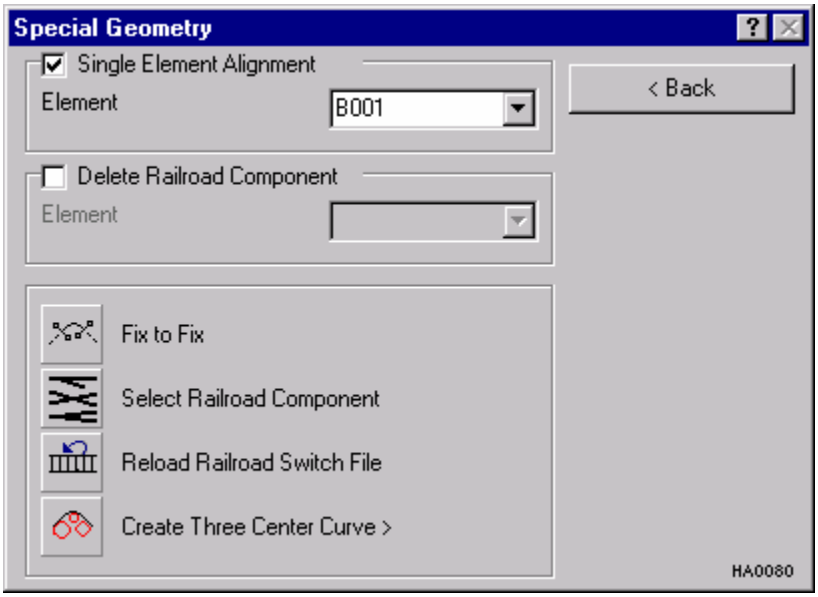


On the Add Arc panel shown to the left, a 157ft long arc with radius 250ft is being appended to an element named A001. This arc will begin at the point coordinates shown.

Add Arc can be used to append an arc to either and existing straight or arc element.

Special Geometry

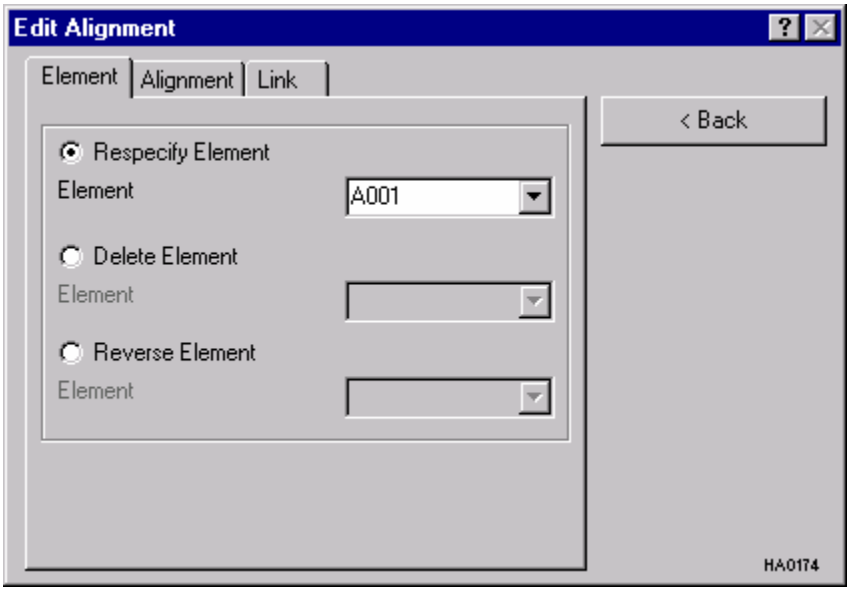
MX alignments normally consist of at least two elements linked together. Sometimes, you may want to make an alignment out of a single element. (A good example of when you're likely to do this is to design a side road.) Since single elements are placed as fixed elements, and no links have been established with adjacent elements, MX doesn't know that this element should be treated as an alignment. Special Geometry will allow us to "violate" the two linked elements rule and create what's known as a ***Single Element Alignment***.



To create a single element alignment, make sure the element is visible in the display area, then check on the Single Element Alignment option as shown on the panel to the left. Click in the element box to put the focus in that box, then click on the single element in the MX graphics display. It will automatically make that element an alignment which can then be manipulated with the edit alignment tools.

Another Handy tool on this panel is the ***Create Three Center Curve*** option at the bottom of the panel. This allows you to easily create/insert compound curves as a unit between two elements in an alignment instead of creating each element separately. The panel is quite self-explanatory and won't be described in detail in this manual.

Edit Alignment - The edit alignment tool is used to edit elements, links, and alignments.



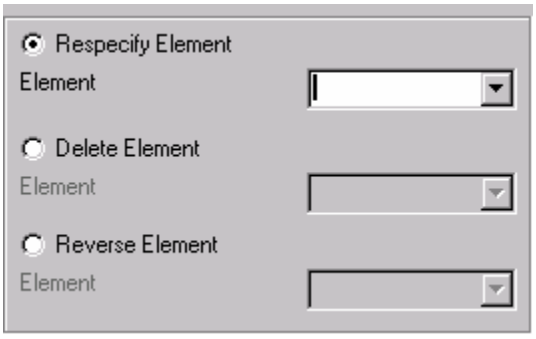
Elements - are straights and arcs that *stand by themselves* and have not yet been linked to another element.

Links - are also elements, but they *have been "linked"* to one or more adjacent elements and are part of the alignment being analyzed.

Alignments - are two or more elements joined together to form an alignment.

There are tabs on the edit alignment panel to edit each of these, depending on what state they are in.

Editing Elements
On the *Element Tab*, you can choose to:



Respecify Element - This tool will recall the panel you used to create the element and allow you to change the data used to define it.

Delete Element - If you have a free-standing element that isn't needed in the alignment, you can remove it with this tool.

Reverse Element - If you inadvertantly create an element heading in the wrong direction, this will allow you to change its direction.

To use any of these options, click the "radio button" next to the option you want, then click in the text box to set the focus on the tool. Then click on the element in the graphics display to fill in the box.

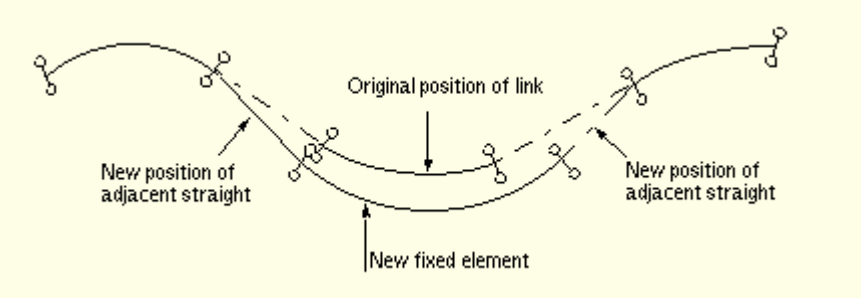
Editing Links
On the *Link Tab*, you can choose to:

Respecify Link - This tool will recall the panel you used to create the element and allow you to change the data used to define it.

Delete Link - If you have a free-standing element that isn't needed in the alignment, you can remove it with this tool.

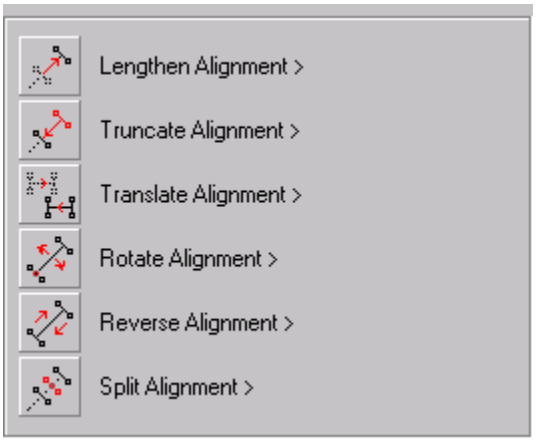
Swap Link - This option allows you to perform localized edits within the alignment. You use it to edit an alignment locally without having to delete those parts of it that need to be changed.

For example, you can swap an analyzed link for an unanalyzed fixed element, with the links adjacent to the original link moving to accommodate the position of the new element, as shown in the illustration below.



The crux of swap link is that the new element is a fixed element regardless of the original fixity of the element it replaces. The adjacent elements, in order to be included in the revised alignment, then become free elements and again this is regardless of their original fixity. (At the ends of alignments the mechanism is slightly different but the principles still hold).

Editing Alignments
On the *Alignments Tab*, you can:



Lengthen Alignment - If, after creating an alignment, you find it necessary to extend it from the beginning or end point, this tool will allow you to do so. You can either lengthen it by a specified distance, or to a point.

Truncate Alignment - If you need to shorten an alignment, this is the tool to use. This is commonly used when designing side road alignments. An example of this will be shown later in this chapter.

Translate Alignment - This allows you to move an entire alignment from one place to another. It requires you to select a reference point on the existing alignment, then a new point where the reference point should be moved to.

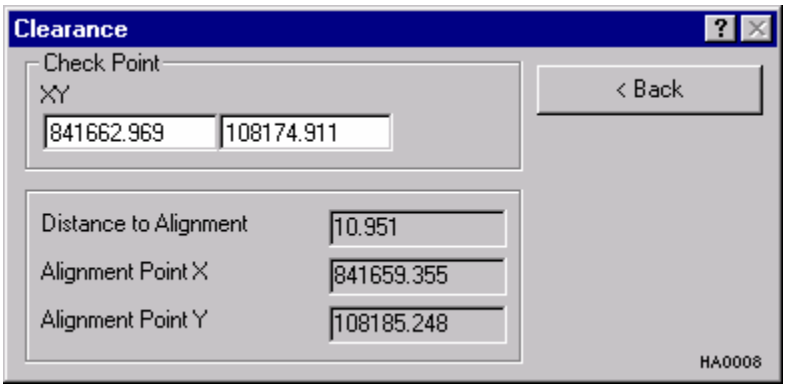
Rotate Alignment - This option allows you to rotate a complete or partial alignment about a defined point by a defined angle.

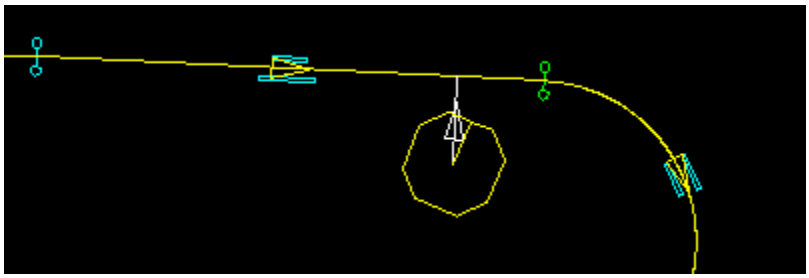
Reverse Alignment - This option allows you to reverse the direction of a completed alignment.

Split Alignment - This allows you to split a continuous alignment into two separate alignments. Each of these alignments can then have elements added to them.

Clearance Checking

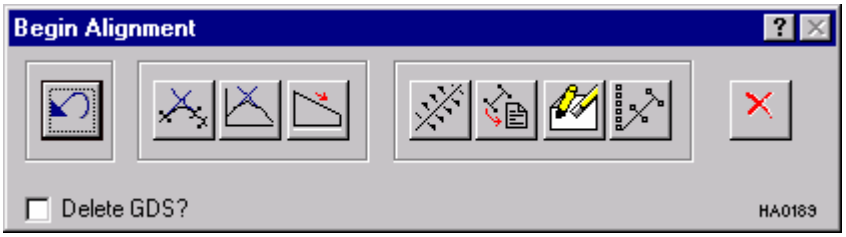
With the Clearance Checking tool, you can pick a point on the display, or type in an XY coordinate pair to see what the normal (perpendicular) distance of that point from the alignment is. It will also provide the XY coordinates of the normal point on the alignment.





Step 6 - Finish the Alignment and Exit The Element Alignment Toolbar. 

This will bring you back to the Begin Alignment Toolbar.



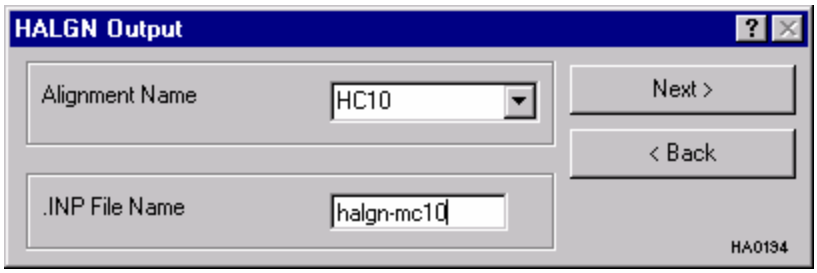
Step 7 - Create HALGN Data

Once you have defined your alignment, you should create HALGN data for it which will be saved in a file to be used later should something happened to corrupt the model file, and it becomes necessary to reproduce your Horizontal Alignment. To create HALGN Data click the Create Data Output tool.

The Data Output Panel will appear. Click the Create HALGN Data button, and the HALGN Output panel will appear:

Click your alignment on the screen to populate the Alignment Name box on the panel, then type a name for the INPUT file that will be created. It's recommended that you use the convention:

"halgn" + M-String Name



IN the example above, the file being created would be named ***halgn-mc10.inp***

Click ***Next*** to create the file.

You now have a record which you can fall back on to recreate your alignment should that become necessary later.

Step 8 - ***Creating The Master Alignment String***

The horizontal alignments created using the element method are just theoretical alignments. These theoretical alignments are stored in a special model called the **Geometry Data Store**. There are no strings stored in this model, just the geometric information that describes your alignment. If you report on the model names within your model file, you'll see that after using the Alignment tool for a specified design model, a second model with a similar name was created with the special characters "GDSGDS" as part of the model name.

```
DESIGN                              1078    Free        22OCT01 12:52:10
DESIGN                    GDSGDS    1124    Free        30OCT01 13:50:50
GROUND                               909    Free        30OCT01 13:52:40
SUBGRADE                            5200    Free        19OCT01 15:19:20
TRAVERSE                               2    Free         3JUL01 12:30:20
TRIANGLES                   TRIA       4    Free        22OCT01 12:52:10
XSMC10                              4764    Free        22OCT01 09:37:30
```

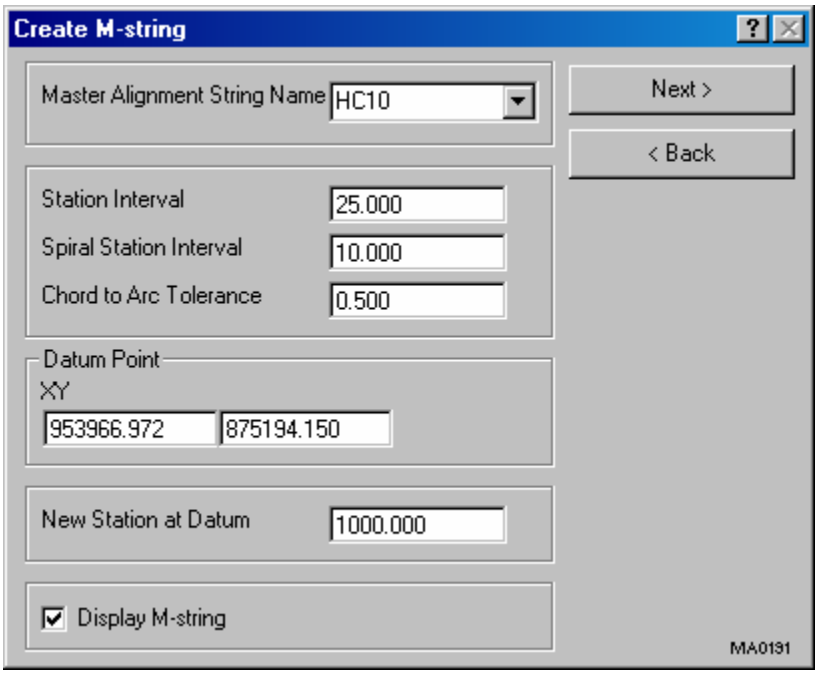
In the sample MX output shown above, the second model listed is the geometry data store associated with the model called "DESIGN". Each model that contains alignments will have a geometry data store created automatically.

When defining an alignment using the horizontal element method, you are actually defining the ***Horizontal Component (HC)*** of the alignment. Later in the design process, you will define the alignment vertically, and define the ***Vertical Component (VC)*** of the alignment.

For the example alignment used in this chapter, "MC10", the horizontal component of that alignment would be named "HC10", and the vertical component would be named "VC10". Similarly, an alignment named "MCA1" would have horizontal and vertical components called "HCA1" and "VCA1" respectively. **The Horizontal and Vertical Components of an alignment are stored in the Geometry Data Store**

We need to make an actual string based on these geometric components.

- Select ***Create Master String*** to define this string. The following panel appears:



Select the alignment you created from the screen, specify a station interval (normally 25 ft).

You can pick a point on your Master Alignment to begin at a specified station if you're trying to match an existing roadway or adjacent project. Click ***Next*** when ready to proceed.

Now you've created your M-String. It has only been defined in two-dimensions at this point (X/Y). Later, we'll add elevations to all of the points on the string.

A second string was created in this process called a **Geometry String, or G-String**. This string is associated with the M-String, and contains information about the IP's, tangents, and curves you just defined. The vertical IP, grade, and curvature data will be added in section B-5.

NOTE: You should redisplay your design model using **Display => Plan with StyleSet** after creating a master string so that it appears in the display correctly with stationing, etc.

Retrieving an Alignment from an HALGN file or GENIO File.

Some time during the design process of one of your projects, you will undoubtedly find the need to "refresh" your Master Alignment and Geometry Strings (MC & GC Strings). Perhaps you will be receiving a new alignment from a team member or engineering consultant. Maybe your model file became corrupt and you need to regenerate all of your design data. Regardless of the cause of your troubles, if you performed the step above which created an HALGN file, you will be able to retreive your alignment and not have to start from scratch! Unfortunately, in order to do this cleanly and efficiently, you will need to recreate all of the alignments in a design model being restored. The procedure for doing so is:

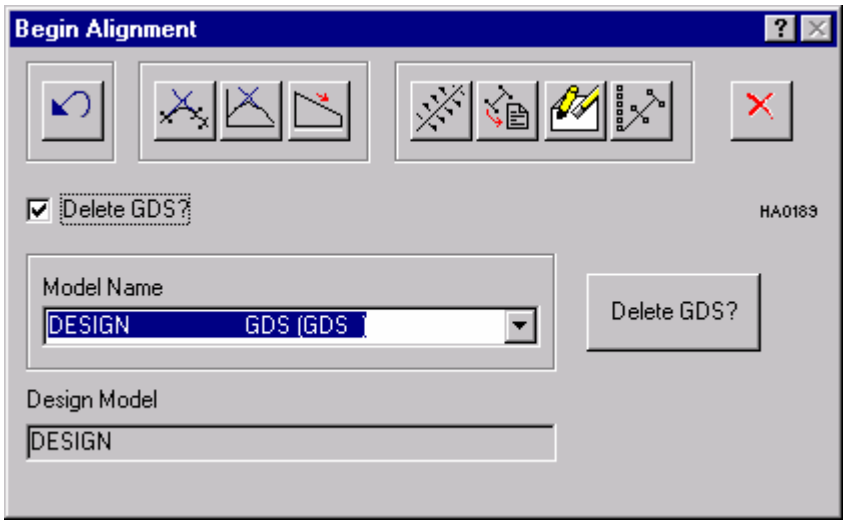
1 - Delete any MC and GC strings that will be recreated by your INPUT file from the model before attempting to run in the file.

2 - Run the INPUT file to create the strings.

3 - Delete the Geometry Data Store

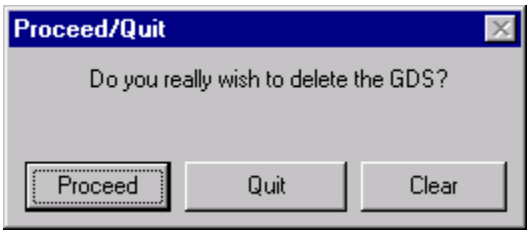
NOTE: Be sure to create HALGN files for each of your alignments before deleting the Geometry Data Store or you will have no way to recreate the alignments!

To Delete The Geometry Data Store enter the Alignment Tool and specify your proposed design model if you are note already in it. Continue through the wizard until you reach the Begin Alignment Toolbar, and ***check the checkbox on the bottom of the toolbar***. The Begin Alignment toolbar will expand to look like this:



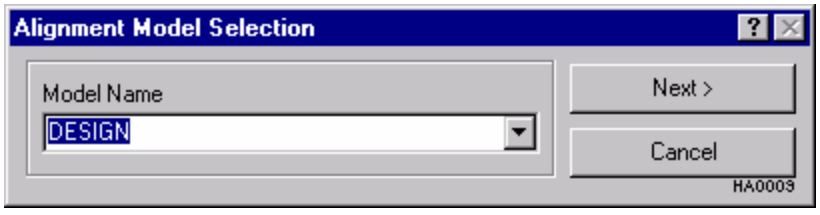
Select the Geometry Data Store model from the drop-down box, then ***click the Delete GDS Button***.

Because this is such an important operation, you will be asked to confirm that you really do want to delete the GDS model.



Click Proceed to delete the Geometry Data Store.

4 - When you do this, you will be asked to reselect the design model for alignments.



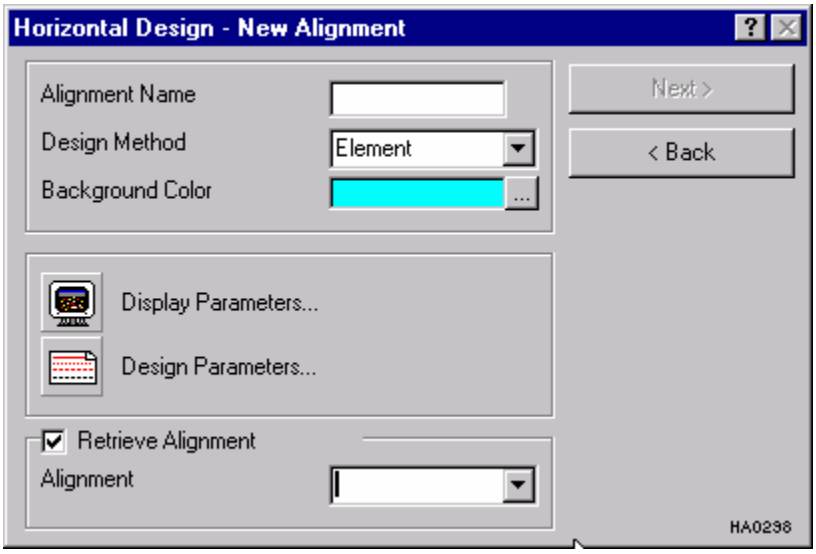
Select your design model again, then click ***Next*** to continue. You will return back to the Begin Alignment Toolbar.

5 - Click the Horizontal Alignment tool again to enter Horizontal Design.

Because you just deleted your Geometry Data Store, those alignments stored in them are gone. In the next step, we will regenerate the geometry data store and retrieve the geometric information from the M-Strings you created above in step 2.

After clicking the Horizontal Alignment Tool, the Horizontal Design - New Alignment Tool will appear if this is the first alignment to be retreived:

NOTE: If you've already retrieved one alignment, you will see a different panel where you can select to Continue an Alignment or Create New Alignment. When retrieving a second or subsequent alignment, click ***Create New Alignment*** to launch the Horizontal Design-New Alignment Panel shown below.



6 - ***Check the Retrieve Alignment Box*** at the bottom of the panel.

7 - ***Click on the M-String*** in the display that you want to retrieve the alignment definition for.

MX will extract the alignment information for the M-String selected and load the alignment name at the top of the panel.

8 - Click ***Next*** to proceed to the Element Alignment toolbar

9 - Click ***End This Alignment*** to save the alignment information in the Geometry Data Store.

Repeat this step for each of the other Master Alignment Strings in your design model.

Creating Side Road Alignments

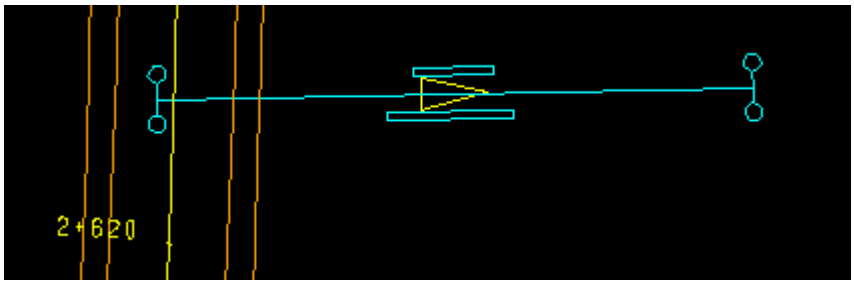
Earlier in this chapter the various element, link, and alignment editing tools were described, as well as a general procedure to come up with a strategy for typical alignments. A slightly more rigid procedure should be followed to design side road alignments. This will ensure that you can tie these side road alignments into your mainline alignment correctly. This section of the chapter will describe this process in detail.

Step 1 - Make sure your main line master alignment string is displayed in the graphics display. (This is the actual MC-String created for this alignment, not simply the horizontal component of the alignment.)

Step 2 - Click Design => Alignment to enter the alignment tool.

Step 3 - When entering alignment after at least one previously-created alignment is present in the geometry data store, the Alignment Display panel is shown. In some cases, you will want to display all alignments, but in this case, ***you don't want to display any alignments***. Just ***Click Next*** to move on. The reason for this is that your side road alignment will be created in such a manner that it overlaps your main line alignment and is then truncated back to the appropriate intersection points. This will become clearer a bit later in this section.

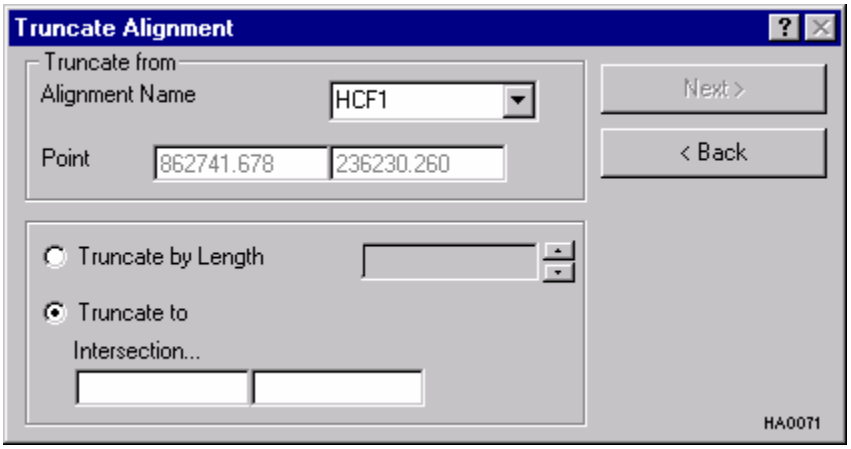
Step 4 - Create your side road alignment as desired, but keep in mind that the element nearest the mainline / sideroad intersection should overlap the mainline M-String.



Side Road Alignment Should overlap MainLine M-String

Step 5 - Select ***Edit Alignment*** from the Element Method Toolbar, and click on the Alignment Tab on the panel that appears.

Step 6 - Click the ***Truncate Alignment*** Tool:



Click on the alignment on the screen to fill in the top box on the screen. *Be sure to click near the end of the side road alignment that's nearest the mainline roadway intersection*, because this tool will automatically pick the end point of the alignment that's closest to where you pick on the screen. That's the end of the alignment that will be altered.

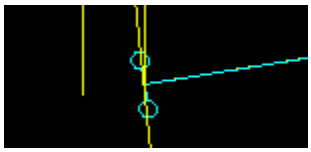
Select the ***Truncate To*** option on the bottom of the panel

Change the point control at the bottom of the panel to the Intersection PSM, and ***make sure that "Multi-Pick" is selected*** on the bottom of the MX application status bar.

When using the Intersection PSM in Multi-pick mode, three clicks are required:

Click 1 - Side Road String
Click 2 - Mainline M-String (MC10, etc.)
Click 3 - an XY point near the intersections of string 1 and string 2.

After these three clicks, you should automatically see a preview of the new end point for the side road alignment:



If it appears correct, click ***Proceed*** on the acceptance panel that appears. If not, back out and try again. When you finally have the correct end point, click Back on the Edit Alignment Panel, then click End this Alignment on the Element Alignment panel.

Don't forget to create an HALGN file and Master Alignment String from this alignment!

All About Point Selection Methods (PSM's)

Point Selection Methods are methods to select points in the display, which will be used to define the points in various alignment elements. There are six point selection methods available. These point selection methods are specific to horizontal ALIGNMENT design, though they are similar to those that are used in other Major Options.

POINT: POINT enables you to find an exact point on an existing feature, either an alignment or an MX string. You can either click on the display area, or type in the appropriate name or point number.

XY: XY selects and displays the actual coordinate position of the cursor, independent of the feature. You can also type in the coordinates.

INTS: INTS selects and displays the point at the intersection of two features, which may be MX strings, alignments, or elements. The intersection may be found between an alignment and a string. For the three prompts you identify both strings and an approximate position for the intersection. If you select Keyboard you may type the response to any prompt.

CONST: CONSTR uses geometrically constructed elements to locate a point. There are three methods that can be used: Single Construct, Intersection of two constructs, or angle between two line constructs. The various types of construct methods are listed below.

Single Construct Point -
- Circle: 3 Points
- Circle: 2 Points and Radius
- Circle: 2 tangents and Radius
- Line: Divide A Line
- Line: Point, Bearing, and Distance
- Line: Angle and distance
- Line: Distance and Offset

Intersection Point -
Circle: Center and Radius
Circle: Center and Point
Circle: 2 Points and Radius
Circle: 2 Points on the Diameter
Circle: 2 tangents and Radius
Line: 2 Points, Offset, and angle
Line: Divide a Line

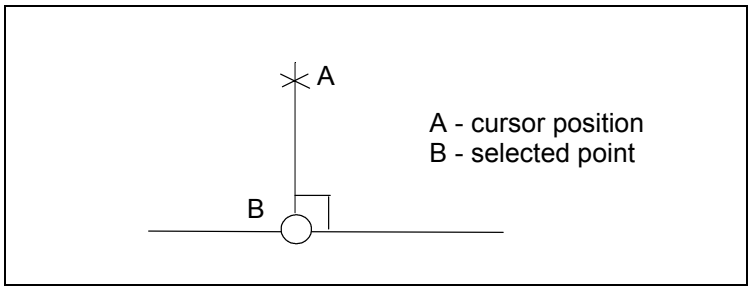
Angle Between Two Lines:
Angle: Two lines, Two Points
Angle: Two Lines, Point and Bearing

IP: This PSM is invoked automatically when you pick an intersection element.

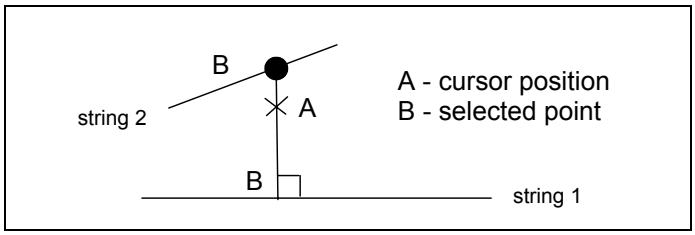
CHAIN To use this PSM you must be referring to 6D Master Strings. You will not be able to determine the station on an alignment or element. If you select Keyboard, then type in the station. A typed station need not be an exact point wheras a point selected by the cursor will return information for an exact point.

NORM: There are three variations using NORM.

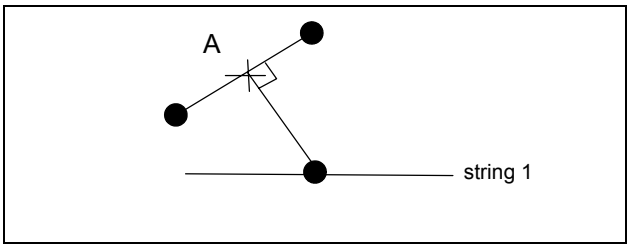
1. Find the point on a feature whose normal passes through the cursor position.



2. Find the intersection point on a feature intersected by a normal erected from another passing through an X/Y point in space



3. Find the point of a feature intersected by a normal constructed from a point on an alternative feature



All cases have the same prompts in MX, but the selection depends on the case:

Prompt 1: the feature on which the point is found
Case 1: select feature 1
Case 2: select feature 2
Case 3: select feature 1

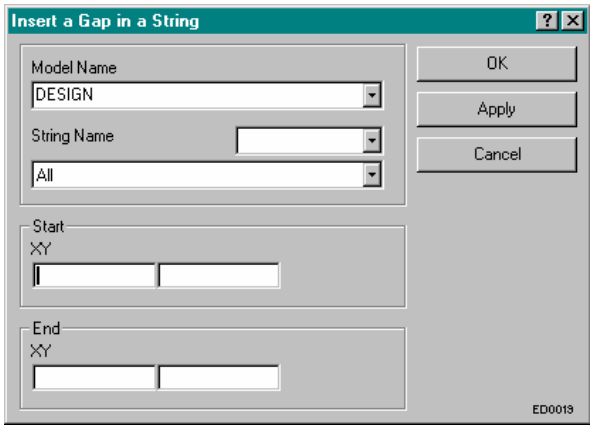
Prompt 2: the feature onto which a normal is to be dropped.
Case 1: select feature 1
Case 2: select feature 1
Case 3: select feature 2

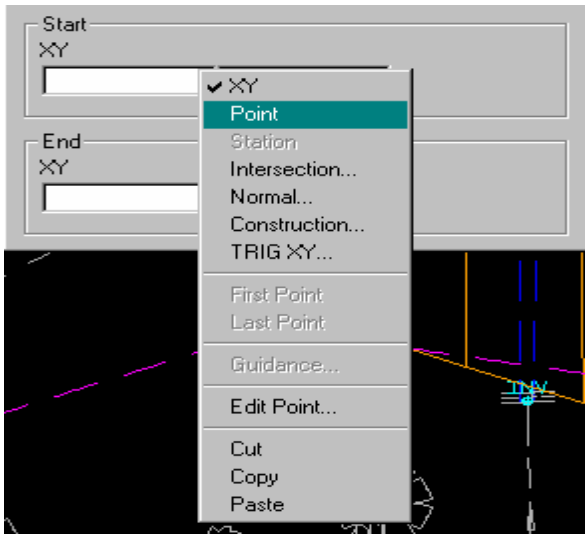
Prompt 3: the cursor position of A. (for identifying point A, all PSMs are valid)

ORIG: ORIG enables you to select the origin of an alignment feature, either an element or an alignment.

Changing Point Selection Methods:

Getting to the Point Selection Methods is really quite easy. To show this process, let's use one of the Modify commands, Insert A Gap In A String. The panel for this command looks like this:

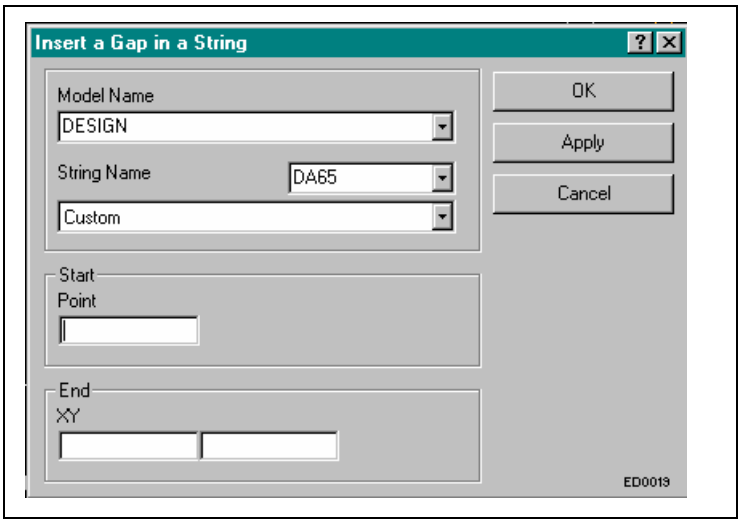




Anytime you have an MX command that is asking for you to enter point data, such as on the bottom of this panel, you can change the PSM by **moving your mouse cursor over the boxes** where the point data is to be entered, and **clicking your right mouse button**. In the panel above, both the start and end points are currently in the "XY" selection method.

When you right-click on the point areas of the command panel, you are shown a pop up menu which allows you to select a different PSM.

In the example above, we've hilighted the Point PSM. To change the PSM to Point, then simply left click when it's hilighted. The original panel for Insert A Gap In A String now looks like this:

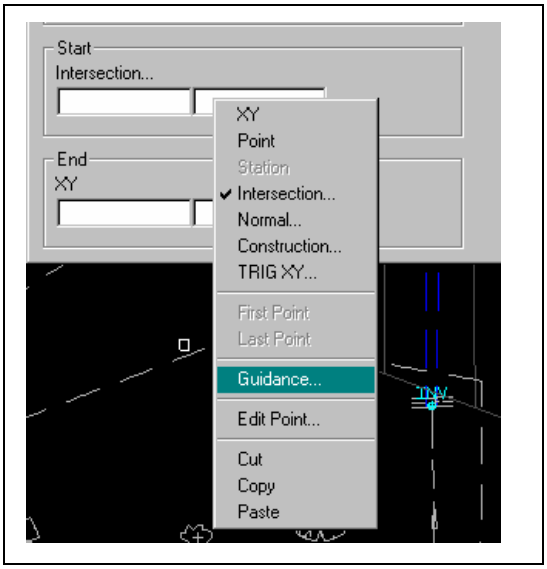


Notice that the start point changed from two boxes to a single box when we selected Point. That's because we no longer need to enter two values, just a single point number.

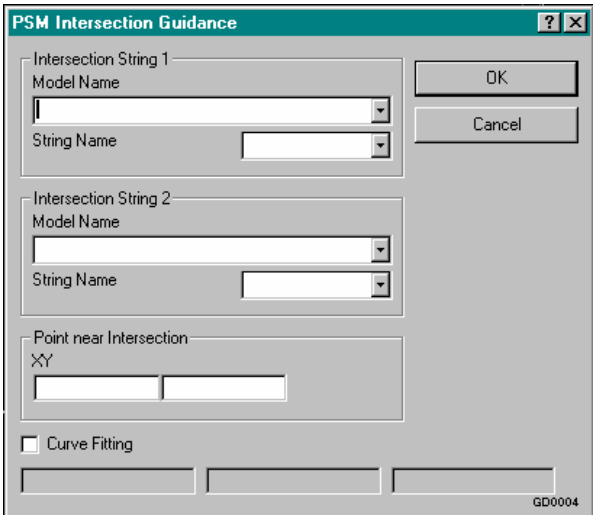
To use some of the more complex PSMs such as Normal, Intersection, and Construct, MX provides a "Guidance" panel which provides you a wizard to lead you through the the process. This is particularly important for Intersection, where you need control over which string is chosen as "String 1" because that's the one that the resulting point's elevation comes from. Here's how you'd get the Guidance Panel for PSM Intersect:

1. With the PSM set to Intersection, right click a second time on the Start Point box.

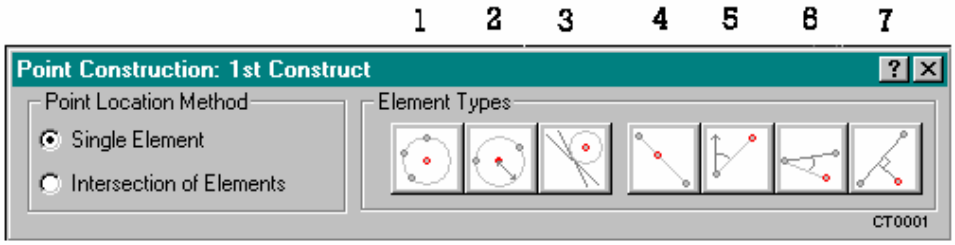
2. The pop-up menu appears again. Move your mouse down to hilight the "Guidance" selection, and left click on it.



The following Guidance Panel will appear:



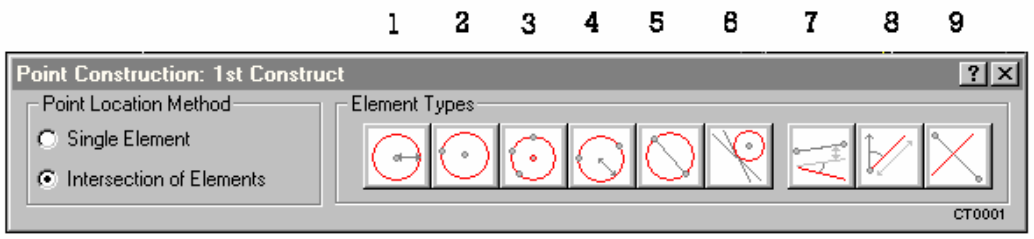
You can see that all of the necessary information can be entered on this panel to determine the Intersection Point just as you did in IGMODE MOSS. Also note that there is a check box on this panel to turn on Curve Fitting if you want. (You normally won't want it on.)



When you select PSM Construct, the following menu will appear:
When "Single Element" is chosen as the method, the icons to the right mean:

1. Circle: 3 Points
2. Circle: 2 Points and Radius
3. Circle: 2 Tangents and Radius
4. Line: Divide A Line
5. Line: Point, Bearing, and Distance
6. Line: Angle and Distance
7. Line: Distance And Offset

If you change the method to "Intersection of Elements", the panel changes to:



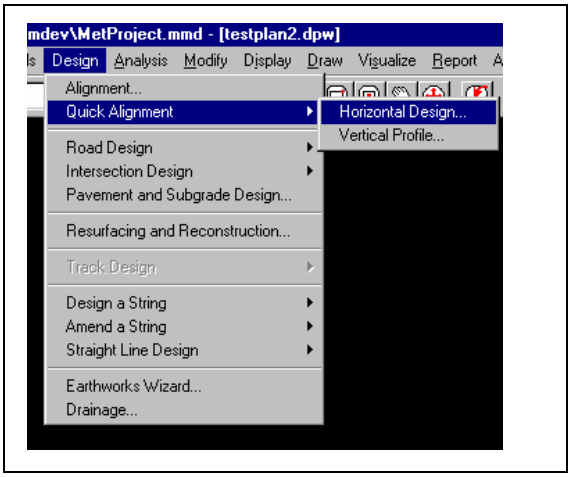
The icons on the right mean:

1. Circle: Center And Radius
2. Circle: Center And Point
3. Circle: 3 Points
4. Circle: 2 Points and Radius
5. Circle: 2 Points On Diameter
6. Circle: 2 Tangents And Radius
7. Line: 2 Points, Offset, and Angle
8. Line: Point and Bearing
9. Line: Divide a Line

Quick Horizontal Alignment

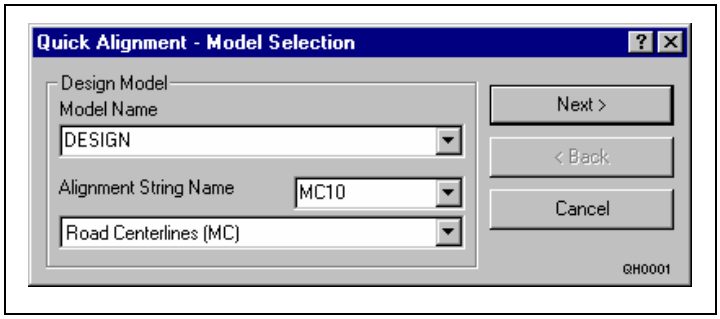
One of the first tools added to the MXRoad software was the Quick Alignment feature. This allows you to dynamically place and move IP's to quickly lay out a horizontal alignment. The following procedure shows how to do this:

Step 1. Make sure you have an MX display(*.dpw) of your existing ground in the display area, then click ***Design, Quick Alignment, Horizontal Design*** from the Menu Bar.



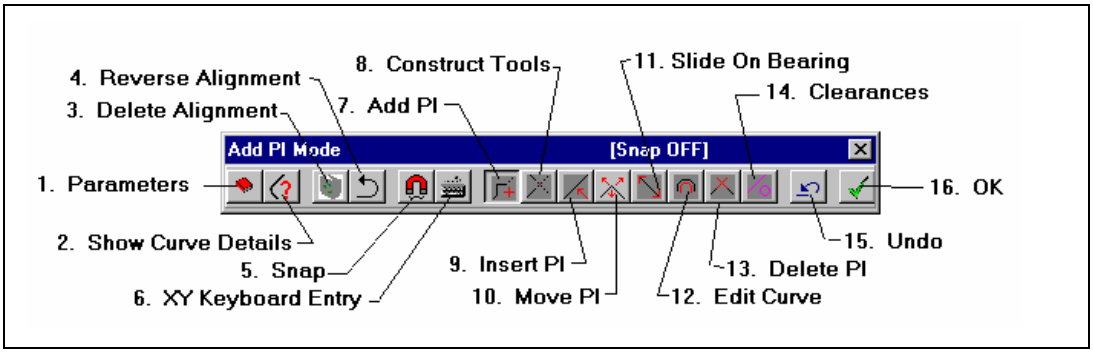
You can see in the drop down menu to the right that the ***Alignment*** choice is also available. This will take you to the standard element method of creating an alignment.

Step 2. The following window will appear:



You can either select an existing Model Name from the drop down box, or type a new model name in to hold your proposed design. If it doesn't exist, you'll be asked whether you want to create a model by that name or not. Then type the alignment string label, MC10, for our first alignment. As you do this, notice the box below the Alignment String Name change to display "Road Centerlines (MC)". This is the feature name associated with strings beginning with "MC" in the MXRoad naming convention. Another way you can do this, is to select the feature name from the drop down box, and MXRoad will automatically select the next available label for you.

Step 3. Click on the Next button after the information is correct, and the Add PI toolbar will appear.



Here is a description of each tool:

1. **Parameters** - Allows you to change the default values for the curves which you create.

2. **Show Curve Details** - Displays the parameters of the curve under the cursor

3. **Delete Alignment** - deletes the entire horizontal alignment

4. **Reverse Alignment** - reverses the direction of the alignment, so the PI's are numbered in the opposite direction, and the master string is reversed when created.

5. **Snap On or OFF** - toggles snapping on or off. If snap is on, any PI you add or move snaps to the nearest existing string point if there is a string within the cursor pick aperture. If there is more than one string, the concurrent string selection panel is displayed from which you can select the string you require.

6. **XY Keyboard Entry** - displays a panel which lets you type in coordinates when you add, move, or insert an PI rather than selecting from the display.

7. Add PI - select a point on the display to create an PI. Alternatively, hold down the left mouse button to dynamically locate an PI and associated tangent. Curves are automatically inserted between each pair of tangents as PI's are progressively added.

8. Construct Tools - constructs each PI in turn using a specified distance and bearing.

9. Insert PI - select a point whwere the new PI is to be inserted into the alignment. Default curve data is used.

10. Move PI - select a point near the PI to be moved and hold down the left mouse button. Drag the PI to the required location. Alternatively, click on the display and the nearest PI is moved to that location.

11. Edit Curve - edits the parameter of a curve.

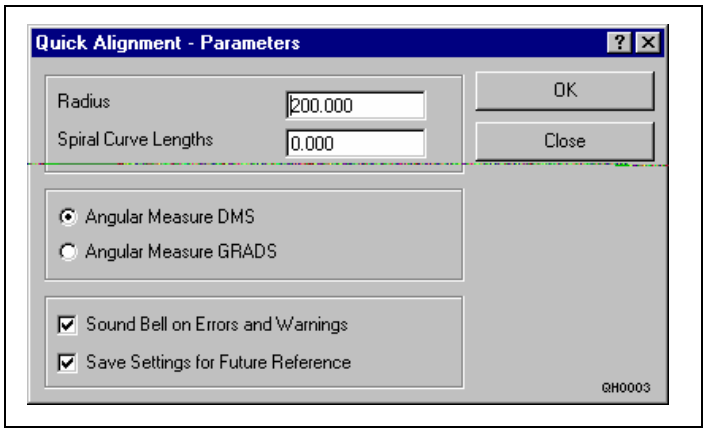
12. Remove PI - select a point near the PI to be removed.

13. Clearances - calculates clearances using clearance lines or circles. (Clearance Checking in Classic MOSS)

14. Undo - click this button to undo the last change you made. You can repeat this up to 20 times.

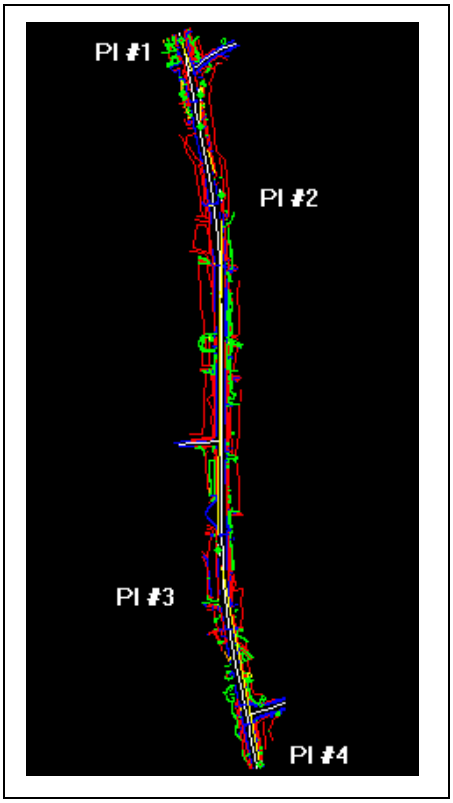
15. OK - click this when you have completed your horizontal alignment design to create the master string

Step 4. Before beginning to layout the PI's, check the curve parameters by clicking on the leftmost tool. You should see a panel like this:

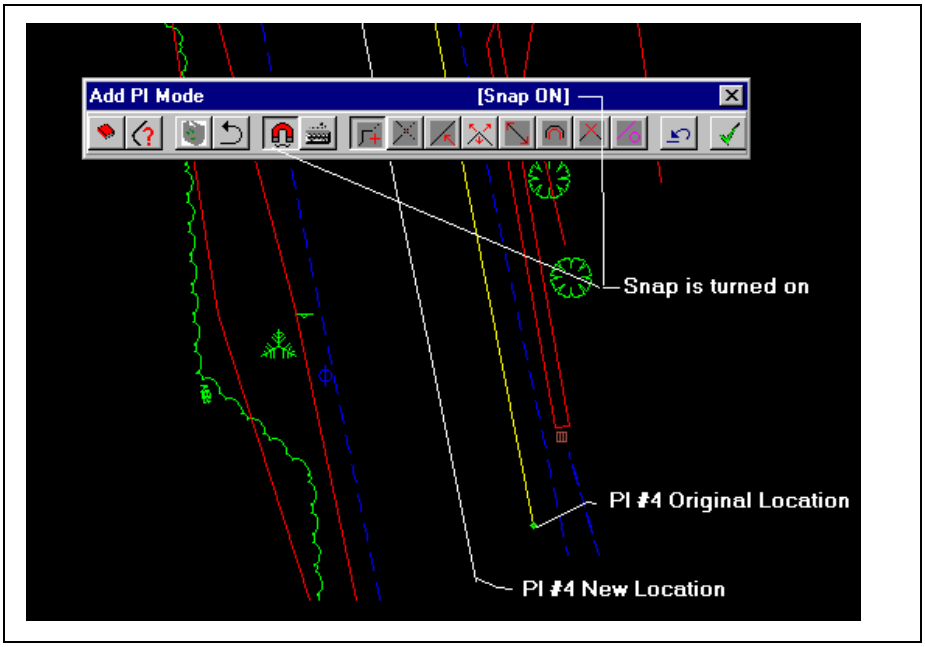


Here you can set the Radius, and angular measure for the default curves that are automatically placed between adjacent tangents as you place your PI's in Quick Alignment. Leave them as the default values for now.

Step 5. Add PI's for your horizontal alignment. If you want to have the PI's located at existing string points, be sure to toggle the Snap tool to "ON", otherwise the PI will be placed at the XY coordinates where the cursor is located at the time the mouse button is pressed. In this example, I've added 4 PI's at the locations shown on the diagram at the top of the next page:

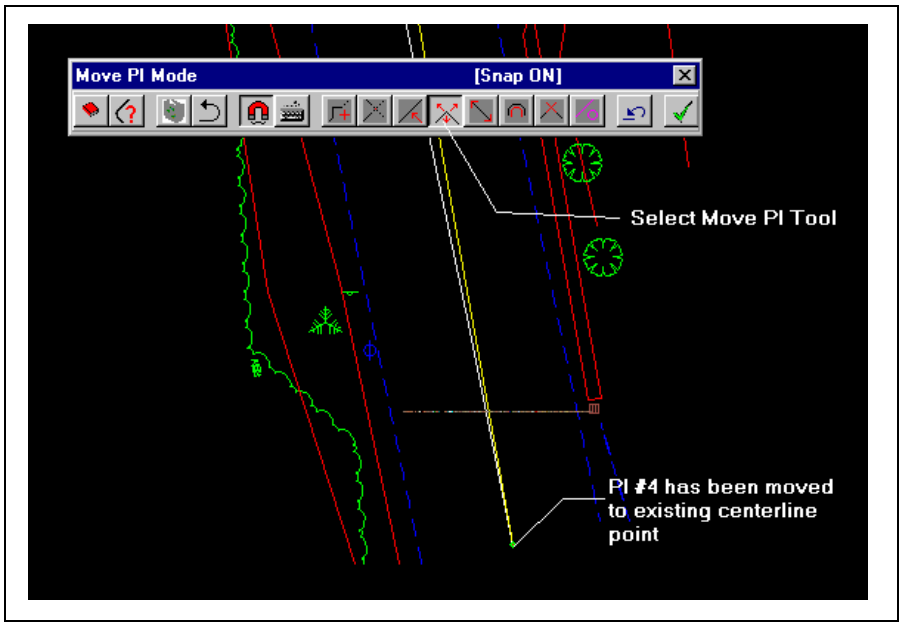


Step 6. Let's zoom in on PI #4 at the bottom of the screen and move it to a point on the existing roadway centerline:



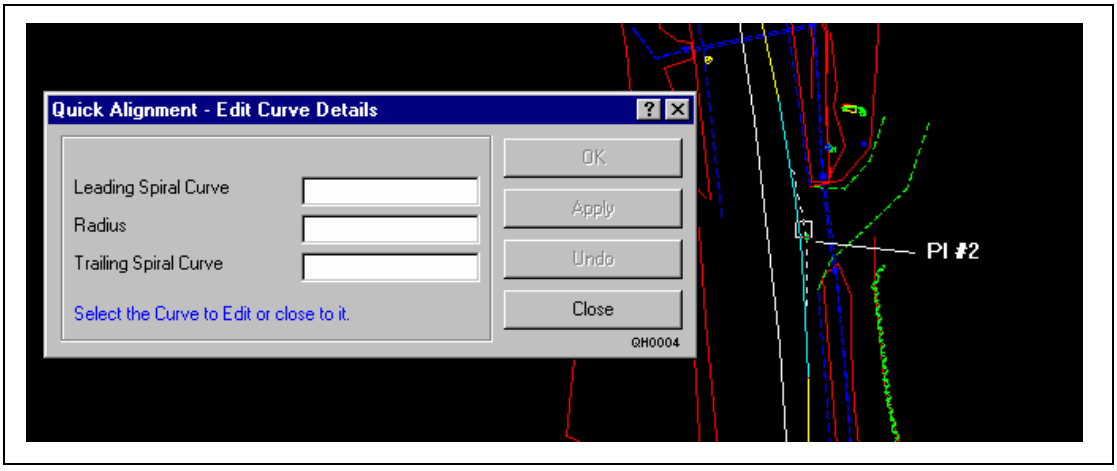
Be sure the Snap Mode is on by clicking the Snap tool in the Horizontal Alignment Toolbar. You can tell for sure if it's on by the caption in the title of this toolbar, "[Snap ON]". Click the Move IP tool, then click and hold on the original PI. Slide your cursor to the new PI location while still holding down the left mouse button, and when you are near the existing

centerline point, release the button. Your PI should jump to the existing point on centerline and look like this:



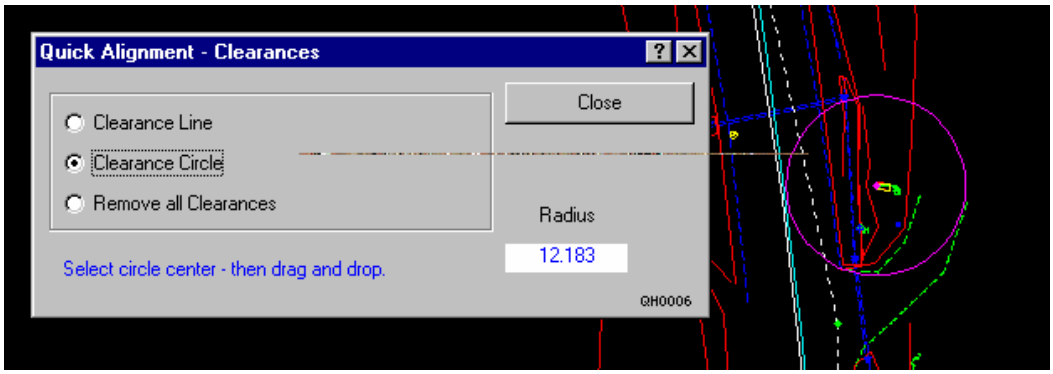
Repeat this for the other end of your alignment, then zoom in on the other PI's and adjust their positions as necessary so that the tangents fall as closely as possible to the existing roadway centerline.

Step 7. Zoom in on PI #2, and we'll edit the curve data.



Click on the ***Edit Curve*** tool to see the panel above. Click on the cyan-colored curve in the graphics area, and the existing curve data will be displayed in the panel. Change the Radius as desired, click ***Apply*** to see the change in the graphics display. You can continue to change the radius value, and apply it until you get an appropriate radius.

Step 8: You can visually check clearances from your alignment to various topographic features by clicking on the ***Clearances*** Tool.



By using the clearance circle technique illustrated above, you can obtain approximate clearances to an object by clicking on (near) the structure or object you want a distance to, then while holding the mouse button down, dynamically drag your pointer towards the alignment until your clearance circle is approximately tangent to your alignment. The distance to the alignment is the radius shown in the panel. More accurate clearances can be obtained from the horizontal design by using ***Report, Geometric Reports*** from the menu bar.

Step 9: Accept the alignment by clicking on the ***OK*** tool. A panel will appear asking for a start station and station interval. Set this information as desired, click ***OK*** again, and your Master String will be created.